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Research Article

Prevalence, Number and Localization of Wormian Bones in Anatolian Adult Dry Skulls

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Abstract

Aim: The locations of the Wormian bones (WBs) are critical knowledge for physicians, anatomists, forensic scientists, and anthropologists. The purpose of the study is to identify the number and location of WBs in the Anatolian population.

Material and Methods: The study included 29 adult skulls from anatomy departments at two universities in Türkiye. The skulls' gender and age were unknown. The prevalence, quantity, and location of WBs were assessed.

Results: The greatest number of WBs (mean 1.79) were found in the lambdoid suture, which was followed by the coronal suture (0.43). Among the fontanelles, the Asterion had the highest number of WBs (0.42).

Conclusion: According to our findings, the Lambdoid suture has the highest number of WBs. There is still a great deal of mystery around the causes of the occurrence and localization of WBs. Radiologists, neurosurgeons, forensic scientists, anatomists, and anthropologists must conduct more research in this area.

Keywords: Wormian bones, Lambdoid suture, coronal suture, Asterion, Pterion.

INTRODUCTION

The bones in the human skull are joined together to form the skull. Wormian bones (WBs) are irregularly shaped bones that develop from independent ossification centers, located on or at the junction of sutures between cranial bones (1). The origin of the name is that Olaus Wormius, a Danish physician, is supposed to have made the initial discovery of these bones (2). These structures are also called sutural bones, supernumerary bones, or ossicles. These ossicles are isolated from other bones by a special suture surrounding them. WBs vary in size, shape, number, and location (3). Even though some studies have suggested that the formation of WBs is genetic, others have suggested that it is physical, and some have proposed a combination of the two, the precise mechanism by which they are formed are still unknown (4-7).

The distribution of WBs in cranial sutures is not homogeneous. They are most frequently seen, respectively, in the lambdoidal and coronal sutures (8). Among the fontanelles, WBs are most common in the asterion, followed by the anterior, posterior, and orbital fontanelles (2). Although WBs can be found in healthy people, they are also associated with diseases, syndromes, or congenital disorders such as pyknodysostosis, osteogenesis imperfecta, rickets, kinky hair syndrome, cleidocranial dysplasia, hypothyroidism, hypophosphatasia, otopalatodigital syndrome, Hadju-Cheney pachydermoperiostosis, Down syndrome, hydrocephalus, cleidocranial dysplasia (2,3,9,10). Because of these associations, WBs can also be used as diagnostic tools in some diseases (11).

Localization of the WBs is important not only for anatomists but also for anthropologists, radiologists, and causality medical officers. Moreover, in autopsy surgery, knowledge of WBs is essential for the correct identification of traumatic fractures of the skull or

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fractures caused by gunshot wounds (12). Despite their clinical significance, limited studies have been done on the number and topographic distribution of WBs in the Anatolian population.

The aim of the present study is to provide a detailed report on the number and topographic distribution of WBs in the Anatolian population.

MATERIAL AND METHOD

In this study, 29 Anatolian dry adult skulls from the anatomy laboratories of Eskişehir Osmangazi University, Faculty of Medicine and Harran University, Faculty of Medicine were used. The specimens' ages and gender were unknown. Since the study was conducted on dry skulls, ethics committee approval is not required. The skulls used in the investigation had no previous surgical procedures and were trauma-free. Only WBs on intact sutures were taken into account. Sutures with even minor damage were eliminated from the study.

The WBs on sutures and bones have been determined individually for the right and left halves of the cranium. The sutures were carefully examined to establish the topographic distribution of WBs.

Statistical Analyses

The number of WBs in each suture was determined separately. Sutures or fontanelles on both sides of the cranium were assessed independently. It was calculated which percentage of skulls contain WBs. The average number of WBs per suture was also calculated numerically. Since the data set exhibited non-parametric characteristics, the Mann-Whitney U test was used to compare the number of WBs on either side of the skull.

RESULTS

24 (82.8%) of the 29 adult dry skulls had at least one WB. In 18 (62.1%) of the adult dry skulls, WBs were found on multiple sutures. The highest number of WBs found in one cranium was 15. There were at least one WB in 15 (53.6%) of the intact Lambdoid sutures. The lambdoid suture had the greatest number of WBs per suture (mean 1.79). A total of 12 WBs were found in a single suture (Figure 1). Of the coronal sutures, at least one WB was found in 6 (21.4%) of them. In general, 0.43 WBs were present per coronal suture. Table 1 lists the major sutures and WBs found in these sutures.

An average of 0.42 WBs was detected in an Asterion. With this number, Asterion contained the highest percentage of WBs among the fontanelles (Figure 2). In Pterion, the average number of WBs was 0.09 (Figure 3). Fontanelles and WBs found in fontanelles are presented in Table 2.

When the minor sutures of the specimens were examined, a total of 6 WBs were detected in the frontozygomatic sutures. A total of 5 WBs were found in sphenozygomatic sutures and 4 WBs were found in parietomastoid sutures. Metopic sutures were found in 3 of the specimens examined. WBs were detected in one of these metopic sutures. All examined minor sutures, and the number of WBs detected are presented in Table 3.

There was no significant difference in the number of WBs between the right and left halves of the cranium for the lambdoid and coronal sutures and for the asterion ($p>0.05$).

Figure 1. Wormian bones located in the Lambdoid suture. 12 Wormian bones (asterisks) in one Lambdoid suture on the skull

Table 1. Major sutures and WBs located in these sutures.

Suture	n	Number of WBs		WBs per suture	
		R	L	R	L
Lambdoid (b)	28	22	28	0.77	1
Coronal (b)	28	5	7	0.18	0.25
Sagittal (m)	29	3		0.1	
Squamosal (b)	20	0	0	0	0

WBs: Wormian bones, R: right, L: left, b: bilateral, m: median

Figure 2. Skull with Wormian bone localized in the Asterion (asterisk)

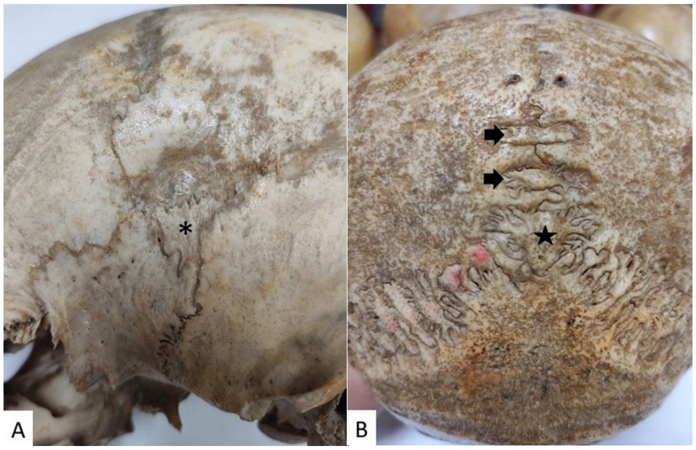

Figure 3. Skull with Wormian bones localized in the Pterion (asterisk), posterior fontanelle (star), and sagittal suture (arrows)

Tablo 2. Major fontanelles and WBs located in these fontanelles

Suture	n	Number of WBs		WBs per suture	
		R	L	R	L
Asterion (b)	26	12	10	0.46	0.38
Pterion (b)	22	1	3	0.04	0.13
Anterior fontanelle (Bregma) (m)	28	0		0	
Posterior fontanelle (Lambda) (m)	29	3		0.10	

WBs: Wormian bones, R: right, L: left, b: bilateral, m: median

Tablo 3. Minor sutures and WBs located in these sutures

Suture	n	Number of WBs		WBs per suture	
		R	L	R	L
Parietomastoid (b)	20	1	3	0.05	0.015
Frontozygomatic (b)	19	5	1	0.26	0.05
Sphenozygomatic (b)	20	3	2	0.15	0.10
Occipitomastoid (b)	20	1	1	0.05	0.05
Zygomatomaxillary (b)	19	1	1	0.05	0.05
Metopic (m)	3	1		0.33	

WBs: Wormian bones, R: right, L: left, b: bilateral, m: median

DISCUSSION

WBs are ossicles located on the sutures. These ossicles are irregular in shape and size. There are different hypotheses that these ossicles are mechanically induced and that they are associated with genetic defects (3). Because of their unusual appearance, these ossicles can be misdiagnosed as fractures during radiographic imaging, which is one of the reasons why these ossicles are clinically important (12,13). Although WBs can also be observed in healthy individuals, they are known to be associated with some cranial or central nervous system disorders (14). Due to the aforementioned important features, it is important to provide information on the early diagnosis of the presence of WBs, as well as the frequency and localization of WBs.

According to the data obtained in the present study, at least one WBs was observed in 82.8 percent of adult skulls. Among the sutures, WBs were most common in the Lambdoid, and among the fontanelles, most common in the Asterion. There was no significant difference in the number of WBs in the right and left halves of the cranium. WB localization was detected in one of the three metopic sutures among our specimens.

In the current study, the rate of adult dry skulls with at least one WB was 82.8%. In the literature, this rate is observed on a very wide scale. In a study conducted in northern India, this rate was found to be 35.3%, while this rate was found to be 80.3% in Chinese (8,12). This wide range of scales may be due to racial differences or physical exposures. In addition, differences in assessment methods may also have contributed to these discrepancies. In the study conducted in the North Indian region, examinations were performed during routine autopsy, whereas we used dry skulls in our study. The changes that occur during drying may have made the sutures more prominent and facilitated the detection of WBs.

WBs were most commonly identified in the lambdoid suture, according to research conducted by Natsis et al. in 2019 on adult dry skulls from Greece (7). In our study, adult dry skulls from Anatolia, a region geographically near to Greece, were examined. In both populations, the lambdoid suture was consistently and remarkably the most prevalent suture where WBs were observed. Many studies have similarly demonstrated that WBs are most commonly observed in the lambdoid suture (12,15). In 2008, ten WBs on the lambdoid suture were described in an Indian case report (16). Similarly, twelve WBs were found on the lambdoid suture in one of the specimens in our investigation. In a study published by Al Kaissi et al. in 2023, it was stated that the Lambdoid suture is part of the brain that bears the most weight (17). However, it is noteworthy that studies are needed to explain why the Lambdoid suture has more WBs than other sutures.

In parallel with the studies in the literature, the fontanella with the highest number of WBs detected in our study was Asterion, followed by Pterion (7,12). Similar to the study by Cirpan et al, no significant difference was found in the number of WBs detected in the right and left asterions in our study (15). The fact that Asterion is the fontanelle with the highest abundance of WBs, consistent with previous studies, is clinically valuable data. However, no valid hypothesis has been proposed as to why Asterion has more WBs than other fontanelles.

Among the minor sutures examined in our study, frontozygomatic, sphenozygomatic, and parietomastoid sutures stand out in terms of the number of localized WBs. The results of the studies examining minor sutures in the literature are similar to the results obtained in our study (7,15). Although only three metopic sutures were observed in the specimens in the current study, one of them had a WB. Although this is a very high rate, the insufficient number of samples prevents this result from being reliable data. Further studies with a large number of metopic suture specimens should be designed to more accurately detect WBs numbers on metopic sutures.

The present study also has some limitations. The most important of these is that the age and sex of our specimens are unknown. Studies on samples with known age and sex will be able to reveal the effect of such variables on the formation and localization of WBs more clearly. In addition, studies in which the number of samples is increased and the region is restricted may provide more effective findings in order to show regional differences in WBs.

CONCLUSION

WBs are crucial for both clinicians like radiologists and emergency physicians as well as researchers including archaeologists and anatomists. Studies that focus on specific regions are more valuable because there is substantial diversity in the prevalence and location of WBs among populations. There isn't enough research in the literature at this point to describe the characteristics of WBs in the Anatolian population. Studies analyzing WBs not only topographically but also developmentally in the Anatolian population will aid in determining a relationship between cause and effect regarding the incidence of WBs.

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Conflict of Interest: *The authors declare that they have no competing interest.*

Ethical approval: *Since the study was conducted on dry skulls, ethics committee approval is not required.*

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